# Porting NETMF

## Beginners Guide

## October 6th 2010

**Rev 0.03**

***This Book in INCOMPLETE***

www.GHIElectronics.com
www.TinyCLR.com

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# Table of Contents

# 1. Change Log

Not active for preliminary releases.

# 2. About the Book

## 2.1. Intended Audience

This book is for beginners wanting to port .NET Micro Framework (NETMF). The users are expected to have good knowledge in C#, C++ and command line compilation.

**I have used my personal free time (if that is ever available!) to make this book. Expect a lot of typos and grammar errors, but please report them on the forum so I can enhance this book.**

## 2.2. Translating the Book

This a book given to the community in an efforts to make NETMF easier to port. If you think you can translate the book to other languages then we would love see your contribution.

**This option will be available after the book is completed.**

# 3. Introduction

Microsoft offers a technology that, in my opinion, is the best thing that have ever happened to the embedded system world. This technology is called .NET Micro Framework, NETMF for short. NETMF is not an OS and at the same time is not an application. NETMF is a system that sits in between your high-level C# code and low-level C/C++/Assembly. At the end, programmers can develop and debug code ease through C# (Visual Basic in future) and Visual Studio. All the amazing features available in Visual Studio are now available to you on a very small systems. For programing libraries, NETMF offers a subset of the full .NET Framework. Any existing knowledge with .NET can be leveraged to any system running NETMF. Developers that do not have experience with .NET can still take advantage of any books or online example code that are targeting .NET since there are a lot of similarities between the full .NET and NETMF.

While NETMF is great, I believe that Microsoft didn't do enough as far as documentation. This why I wrote the first book aimed for beginners wanting to use NETMF and this second book is for developers wanting to port NETMF to their hardware.

## 3.1. Advantages

If you are using .NET Micro Framework then there are many advantages, here just a few:

1. It runs on Microsoft's Visual C# Express, free and and high-end IDE.
2. .NET Micro Framework is open-source and free.
3. Your code will run on all these devices with almost on changes.
4. Full debugging capabilities. (Breakpoints, stepping in code, variables...etc.)
5. Has been tested in many commercial products so quality is assured.
6. Includes many bus drivers. (SPI, UART , I2C...etc.)
7. No need to use processors data-sheets because of the standard framework.
8. If you are already a PC C# programmer then you are already an embedded system developer with NETMF!

# 4. Porting vs GHI's Offers

There are two sides of working with NETMF, porting it and using it. For example, writing a JAVA game on a cell phone is much easier than placing the JAVA virtual machine (JVM) on a phone. The phone manufacture did all the work of porting JAVA to their phone and game programmers can use it with  less effort. NETMF works the same way, porting is not easy but using it is very easy.

Now, When using a GHI NETMF product, you are not paying for NETMF but for the free and unlimited **features, support, maintenance, robustness and time-to-market.** Let's cover these in detail.

## 4.1. Features

GHI NETMF products include many exclusive features, such as USB Host, USB Device, one-wire, CAN, PPP, WiFi; too many to list here. All these are included at no additional cost. GHI continues to adds exclusive features via updates free of charge!

## 4.2. Support

Our world-class support is free. The same engineers that invented these devices are monitoring the forums, emails and phone to provide superior support. We're here to assist you every step of the way until your product is on the market as soon as possible. We would love for you to visit our forum and ask other customers how satisfied they are with GHI support.

## 4.3. Maintenance

Every few months, Microsoft releases a new NETMF version. GHI works very closely with Microsoft on any new possible issues and does all the work required to update all GHI's NETMF devices. For GHI customers, this is a five minute FREE firmware update and GHI takes care of the rest.

## 4.4. Robustness

There are thousands of GHI's NETMF devices used around the world in most markets. This vast usage guarantees quality and stability of GHI Electronics products. You can use any of the GHI Electronics products with ease of mind.

# 4.5. Time-to-Market

Using GHI Electronics' NETMF products will speed up development. Your design is almost done as soon as you add one of the GHI NETMF products. We have seen customers that create full products in a week! You can for example, take a FEZ Rhino starter kit, write a little code over a few days, add your company's logo-sticker on top and you have your own product. You will probably spend most of your time designing/ordering the logo-sticker than you would spend on the hardware design!

# 5. Selecting a GHI Device

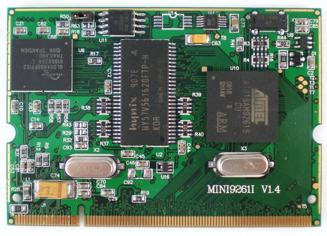
GHI Electronics offers an extensive range from the very basic to the very advance.

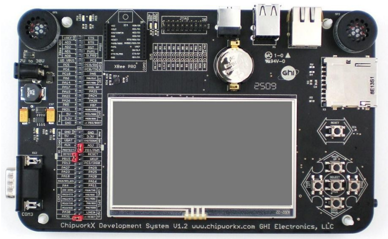
- ChipworkX
- EMX
- USBizi
- FEZ Family
  - FEZ Domino and FEZ Mini
  - FEZ Rhino
  - FEZ Cobra
  - FEZ Panda

...and many more.

## 5.1. ChipworkX Module

If processing power and customization is needed then this is the right choice. ChipworkX runs a 200Mhz ARM processor with 64MB 32-bit SDRAM and 8MB for user applications. It also contains 256MB internal flash for file system storage. It includes all NETMF major features and adds GHI exclusive features like WiFi and USB host support.

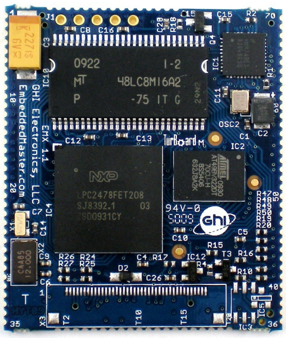


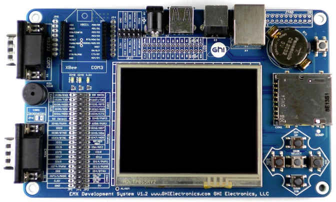

ChipworkX Development System V1.2 www.chipworkx.com GHI Electronics, LLC

ChipworkX also adds SQLite database support and allows users to load their own native code (C/assembly) on the device using RLP (Runtime Loadable Procedures). RLP allows for advance processor intensive and real-time applications.

## 5.2. EMX Module

This small module includes all NETMF major features and adds many GHI exclusive features. On the software side: File system, TCP/IP, SSL, Graphics, debugging and more NETMF features are included. GHI also adds: WiFi, PPP, USB host, USB device builder, CAN, Analog in/out, PWM and more. As for the hardware: It is 72Mhz ARM processor with 8MB SDRAM and 4.5MB FLASH.

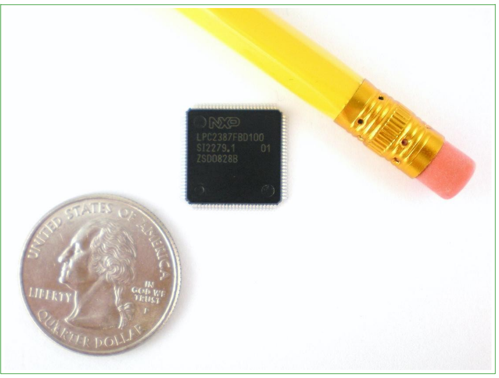




The processor on EMX contains Ethernet MAC built right in with DMA transfers, which gives it a large boost when compared with classical SPI-based Ethernet chipset used by others.

## 5.3. USBizi Chipset

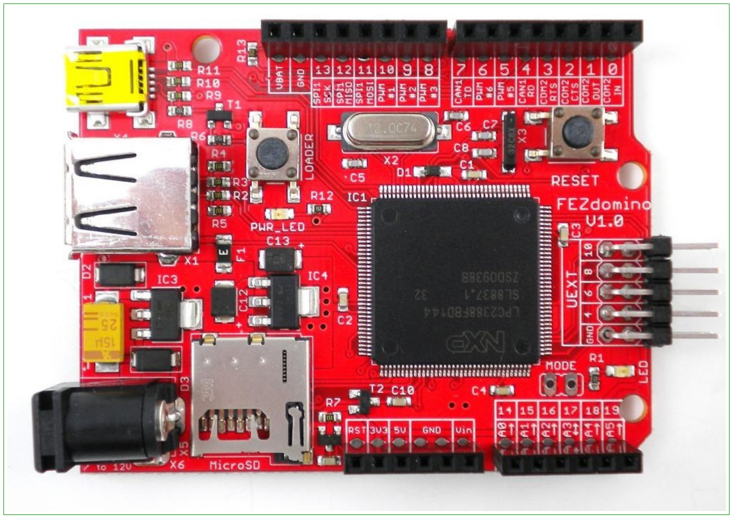
USBizi is the smallest and only single-chip running NETMF in the world. The software running on it is a scaled down version of Embedded Master. It includes all features except networking (TCP/IP and PPP) and native graphics. Even though these features are missing, USBizi can be connected to a network using TCP/IP chipsets like WIZnet and can run simple displays. There are example projects already provided showing how USBizi can be networked and can display graphics.

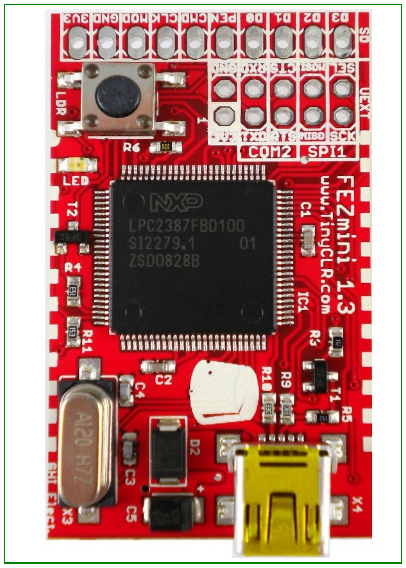


# 5.4. FEZ Family

## FEZ Domino and FEZ Mini

FEZ Domino and FEZ Mini are very small (open source) boards targeted for beginners. They are based on the USBizi chipset. FEZ offers many peripherals, such as USB host and SD interface, not available with many hobbyist-targeted boards. Even though FEZ is targeted for beginners, it's also a low-cost starting point for professionals wanting to explore NETMF.



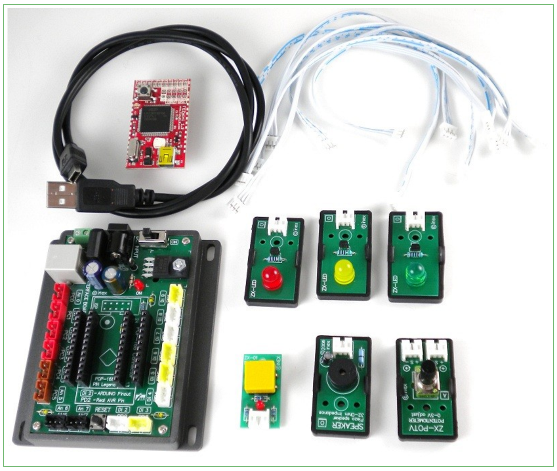


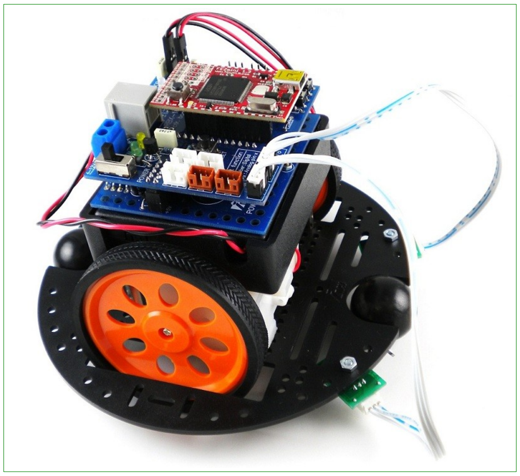
FEZ stands for “Freakin' Easy!”

FEZ offers many features not found in Arduino, BASIC STAMP and others:

- Based on Microsoft's .NET Micro Framework.
- Runs on a 72Mhz NXP ARM processors.
- Supports run time debugging (breakpoints, variable inspection, stepping, etc.)
- Uses Visual Studio 2008 C# Express Edition for development.
- Advanced capabilities like FAT, USB device and USB host.
- Easily upgrades to hardware such as Embedded Master.
- Open source hardware design files.
- Use existing shields and holder boards.
- Based on the USBizi chipset (ideal for commercial use).
- FEZ Mini pin-out compatible with BS2.
- FEZ Domino pin-out compatible with Arduino.

When using FEZ, the possibilities are endless...



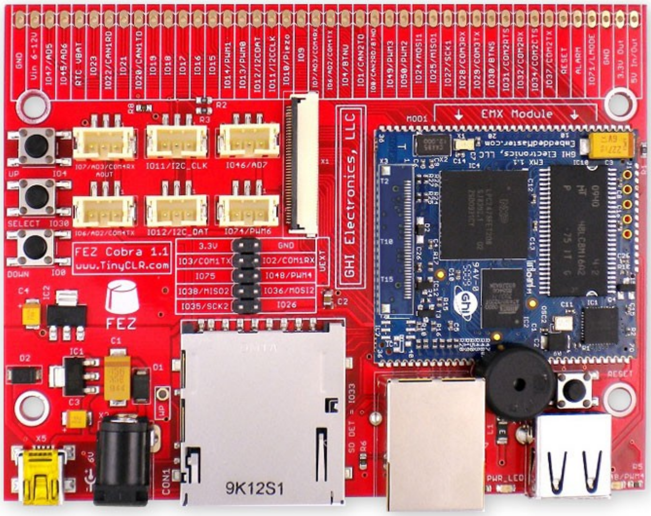


There is a numerous amount of sensors that are ready to plug directly into the kits. From LEDs and buttons to reflection and temperature sensors.

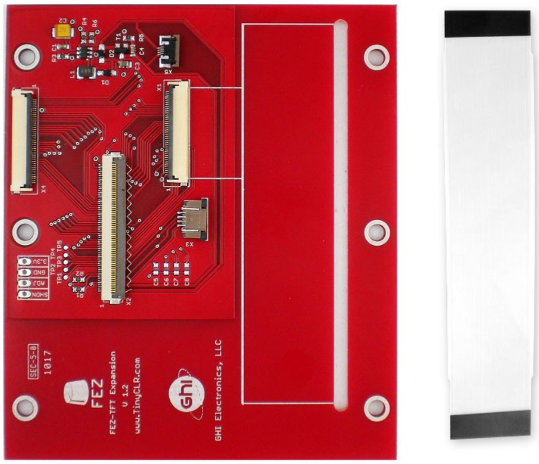
**These book examples are made for FEZ devices.** In general, the examples are still for .NET Micro Framework, so modifying it to run on any NETMF system should be an easy task.

## FEZ Cobra

FEZ Cobra is an open source circuit board based on EMX module. With multiple optional displays, optional enclosure, native graphics support, native Ethernet support with SSL, and megabytes of memory, FEZ Cobra is ideal for those high-end projects. Not to forget that this is still FEZ so it is Freakin' Easy to use!



An LCD expansion board is available to hold either 3.5” (320x240) or 4.3” (480x272) displays.



## Other Devices

GHI strives to deliver the latest technologies dynamically to its customer needs. There is always something new at GHI so please visit www.GHIElectronics.com and www.TinyCLR.com for the latest offers.

# 6. Supported Processors

ARM is the most common processor used with NETMF but other processors are also an option. I usually see this about once a week “How do I run NETMF on my PIC or AVR?” or “I want to run NETMF dsPIC32”. If you are a beginner, here is a simple answer, you can but it is not going to be easy to use anything beside what is officially supported in the NETMF porting kit, and only ARM for first time porters. But wait, there is a more complicated answer! I will try to explain it in details since this is a common subject and sometimes users look down on NETMF not knowing the power of this free product. First of all, NETMF is not a simple library. This is not the 10 source code files that most microcontroller users are usually used to build (TCP/IP, FAT...etc.). This is a very large system with thousands or probably millions of lines of code. Not every processor is capable of handling such load. Do not expect to find a “main” function to learn NETMF. I have seen developers ask this actually, “Where is main function or main execution loop?”.

Now, if your processor is not 32-bit then you may want to forget about NETMF. Even if it worked, it would be too slow. The good news is that most processor manufactures are moving in 32-bit direction, why not I always say. Assuming you have a 32-bit processor such as AVR32 or dsPIC32 then, **in theory**, it is possible to port NETMF build-system to your processor's compiler and it is possible to port the HAL layer to your processor. While this is possible, I will say do not try this unless you are a very much an expert in porting NETMF and have done few NETMF ports from scratch. Proving that NETMF can run on processors other than ARM, NETMF 4.1 ships with ports supporting Renesas' SH processors.

## 6.1. Bootstrap

Most programmers are used to see “main” as the starting point to their programs. This is not entirely correct. There is a lot of code that runs first to initialize the processor, memories and runtime system before “main” is executed. This is called bootstrap. Bootstraping is very much processor dependent. It initializes the system clocks and enable required peripherals. Now, if you are using an ARM processor other than what is already in the PK, you will be needing to write your own bootstrap code. Doing so is very difficult to debug usually. Since the system hasn't run yet, there is no way to send debug messages to a serial port or to display. Even JTAG may not work properly before clocks are setup properly.

If you look at the available NETMF devices on the market, they are almost all using a processor that is already found in the porting kit. As far as I know, GHI is the only company who went far enough to provide a product that needed a completely write of NETMF port, for NXP LPC2478 processor. The current PK includes this port but GHI had it available long time before hand. By the way, this was GHI's very first product too. Why did GHI go the difficult route and not just use one of the ports in PK like others do? Simply, GHI wanted to master the porting kit. Mastering the PK allowed GHI to add a lot of exclusive features that made NETMF even more powerful. This step was very difficult for GHI since NETMF had many bugs that slowed GHI. NETMF wasn't tested enough on porting since most just used what is in the PK. I am talking about NETMF 2.5, we are now at NETMF 4.1 which has matured much and is very solid, big thanks to the NETMF Team, who by the way helped GHI very much.

## 6.2. Peripheral Drivers

Assuming you listened to my suggestion and selected ARM as the processor you want to use, now what ARM processor? The core NETMF will simply run on any ARM processor, that is easy. But, the NETMF needs a lot of hardware access to function properly. At the bare minimum, it needs timers. Same as earlier “bootstrap” story, you really should use one of available ports, at least to start learning. Another good option is to use a processor from the same family. For example, if you want to use LPC2387 processor, the porting kit already has LPC2478 which has a compatible set of peripherals. In fact, this is what I will use for demonstration throughout this book.

# 7. DIY NETMF Hardware

Although working with porting NETMF can be a little bit complex, you can create your own NETMF device very easily and almost for free (you still need to buy the raw components). Just use one of the processors in the porting kit. I wanted to test this myself so I started from scratch just to see how long it would take to create my own device, software and hardware. I was actually able to do it in one weekend while watching TV!

These are the steps I took to create this device, which I call FEZ Hacker:

## Find a suitable Processor/Board

I want to make a simple device, no external memories. Currently, the simplest option is SAM7_EK, which is a port for AT91SAM7X-EK Evaluation Board from Atmel.

Here is the User Guide Which also includes full schematics:

http://www.tinyclr.com/downloads/FEZ%20Hacker/AT91SAM7X-EK.pdf

## Select a PCB Design Software

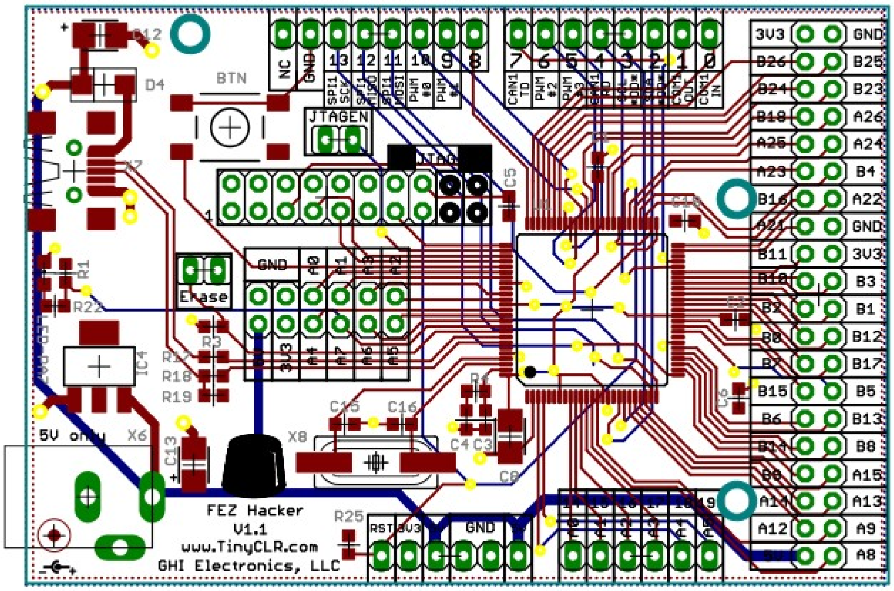
I only need to copy the schematics to create my own board. I will be using the free version of EAGLE, found at http://www.cadsoft.de/ for schematic capture and PCB layout.

## Finding Component Packages

Do not reinvent the wheel. If you look enough, you will find packages for everything you need to create this board, FEZ Hacker. For example, the main component, which is the processor, is already made by someone and it is found at EAGLE website. Just click on “Libraries” on this page http://www.cadsoft.de/download.htm. All other components like resistors and capacitors ship with EAGLE. Do not worry about finding all that, I am giving you the design files.

## PCB Layout

Now, how do we want our circuit board to look like? I would say make it an Arduino pinout compatible so you can use the many available shields. But, this processor has a lot more IOs that what is on Arduino board that we do not want to lose. This is easily solved by extending the board slightly on one side and add another header. I will take the open-source FEZ Panda or FEZ Domino design files to get started then modify it to fit the plan.



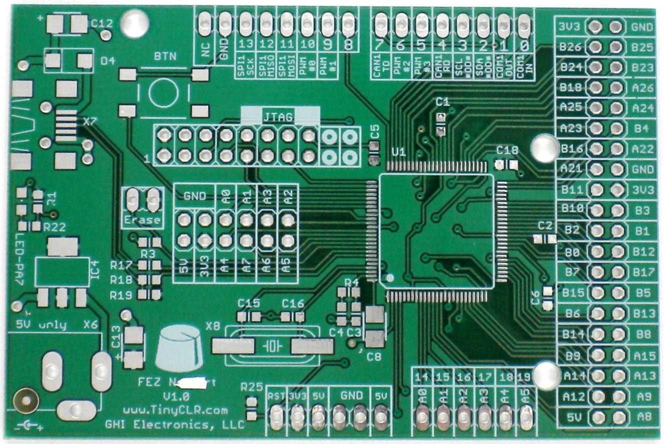
You can see that I even added a JTAG to the board. JTAG is not needed for NETMF usage but it is handy since I can use this board for anything I like.

The design files are found at: http://www.tinyclr.com/downloads/FEZ%20Hacker/FEZ%20Hacker%201.1.zip

## Ordering the board

When running all traces and running some verification scripts, we are ready to order the PCB. There are too many websites that would love to make these boards for you. I used www.my4pcb.com

Few days later and I received this board.



## Soldering

You can send the board to places like http://www.screamingcircuits.com/ or you can have more fun and assemble the board yourself. I have few videos on YouTube on how to solder if you are interested in watching them

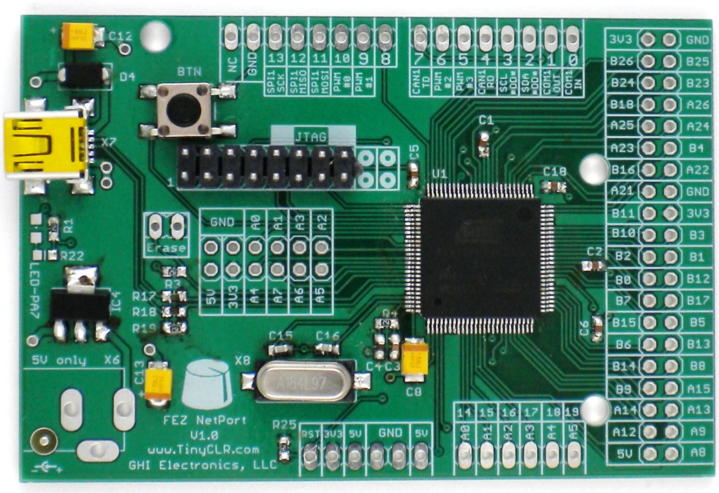
1 of 4: http://www.youtube.com/watch?v=QEEV3AZjRMM

2 of 4: http://www.youtube.com/watch?v=RPtLviWt06A

3 of 4: http://www.youtube.com/watch?v=JtAv3Le0eoA

4 of 4: http://www.youtube.com/watch?v=MvuRXWzk9_c

After some soldering, we get this beautiful FEZ Hacker. Feel free to make your own. I am only asking you to keep www.TinyCLR.com on the board and keep the FEZ Hacker name. Do not to add your name to your own board so everyone knows who made them.



## Loading Software

Chapter **FEZ Hacker Firmware** details this step. You need to instal few software components first.

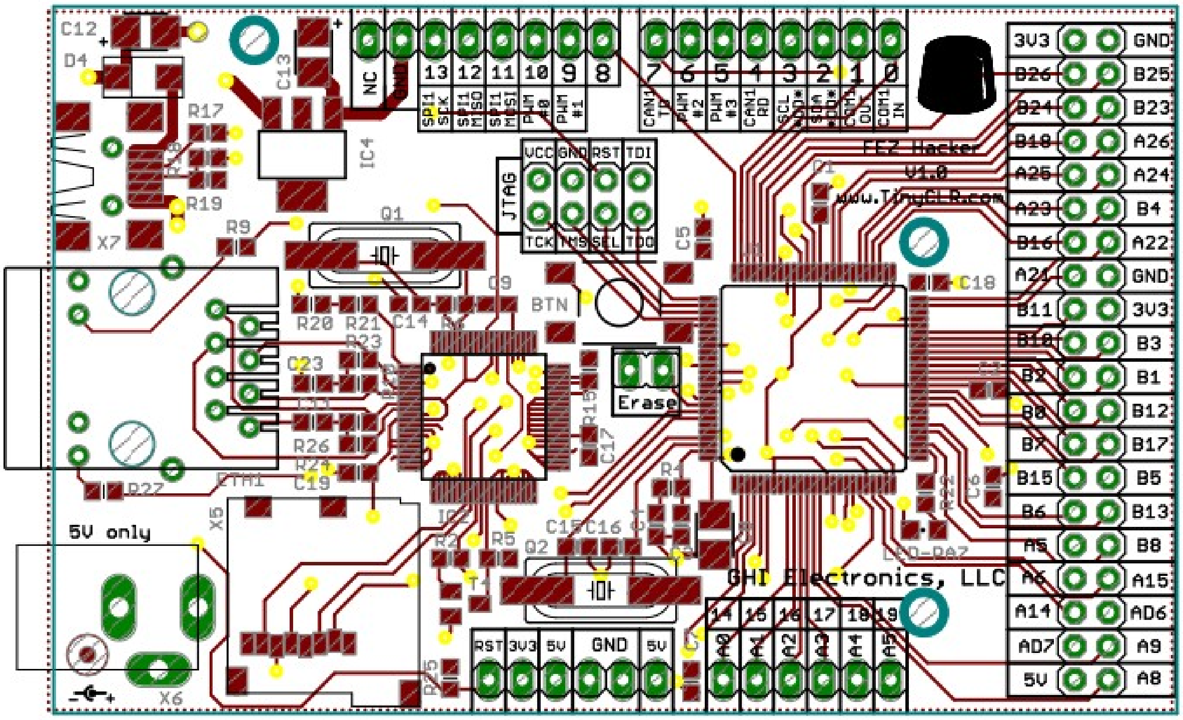
## FEZ Hacker vs FEZ Panda

So, why am I also referring to FEZ Panda porting since we have this board?

SAM7 port is already included in the porting kit so you will not learn much if you use it. I will be using the FEZ Panda processor (LPC2387) to explain the porting procedure better. Not only that, LPC chips cost less than SAM chips. Which I do not understand why since LPC chips are faster and have more features, SAM only has more RAM, 96K vs 128K.

# 7.1. Taking DYI to the Next Level

We saw how we easily copied schematics to create our own Arduino-compatible NETMF board. Now what about making it even better? For example, take the Ethernet shield design and merge that right into your board. You will end up with on-board Ethernet.



You can find the complete design files at

http://www.tinyclr.com/downloads/FEZ%20Hacker/FEZ%20Hacker%20Ethernet%201.0.zip

So why did I use WIZnet W5100 instead of using the NETMF built in LWIP stack? Simply, if you use LWIP, you will end up with very little resources (or no resources) that the system become unusable. If you want to use LWIP then you need a lot more RAM/FLASH than a single chip has internally. And if you were able to fit it all, you will end up with limited networking, even more limited that what WIZnet W5100 gives you.

# 8. Software Setup

Before we do anything, we want to make sure our system can compile one of the example ports with no modifications. In the following steps, we will install all the needed software and compile one of the built-in ports. I will assume the users own no software so we will use free software throughout the book, after all NETMF is free.

## 8.1. Visual Studio Express

You will need C# and C++, so install both. Here is where you can find the downloads http://www.microsoft.com/express/

Once Visual Studio is installed, try to make a simple windows application, compile and debug...etc. We basically need to make sure all is good before we move on to the next step.

## 8.2. Microsoft NETMF SDK

The next step is to install the Microsoft NETMF SDK, not the porting kit, just yet. At the time this book was made, the latest version was NETMF 4.1. The download is available at this link

http://www.microsoft.com/downloads/details.aspx?familyid=CFF5A7B7-C21C-4127-AC65-5516384DA3A0&displaylang=en

When done installing, run a “Hello World” application using the emulator. If not sure how, use this book http://www.tinyclr.com/downloads/Beginners%20guide%20to%20NETMF.pdf

## 8.3. GHI NETMF SDK

This is an optional download if you want to try your GHI-device exclusive features. All downloads you need are on this page http://www.tinyclr.com/dl/

## 8.4. Microsoft NETMF Porting Kit

This Porting Kit includes all NETMF amazing source codes. At the time this book was made, the latest version was NETMF 4.1. The download is available at this link

http://www.microsoft.com/downloads/details.aspx?FamilyID=ccdd5eac-04b1-4ecb-bad9-3ac78fb0452b&displaylang=en

## 8.5. GNU GCC Compiler

Fortunately, the NETMF team added support to free GCC compiler. This is ideal for free use but produces larger firmware size than other commercial compilers, RVDS for example. Knowing that the ARM RVDS tools are few thousands dollars, using GCC with larger code size is not a bad idea anymore. This is a good place to mention that GHI uses RVDS for its development, which should be the best compiler available for ARM processors. This allows GHI to fit as many features as possible in those exciting little chipsets/modules.

NETMF is tested to work with GCC package made available by

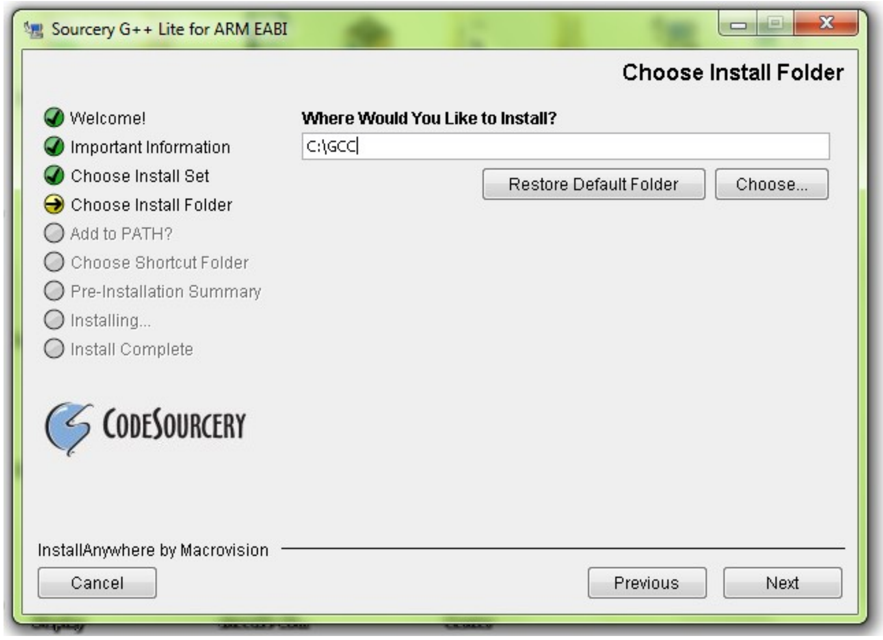
http://www.codesourcery.com/

Now, you can't just use the latest version you can find as changes on GCC may cause the NETMF compilation to break. You will need to use a specific version. For NETMF 4.1, I use arm-2007q3-53-arm-none-eabi.exe found at this link

http://www.codesourcery.com/sgpp/lite/arm/portal/release316

You will need to download the windows package, **do not install just yet!**

The NETMF PK build system has a problem compiling GCC build if the GCC path has spaces . So, you will need to use the old “8.3” naming so instead of “C:\Program Files\...” use “C:\PROGRM~1\...”. I still highly recommend the GCC tool-chain is installed in the root of your hard drive with the simplest possible name. I simply used “C:\GCC” for the installation location.



Sourcery G++ Lite for ARM EABI

Choose Install Folder

Where Would You Like to Install?

C:\GCC

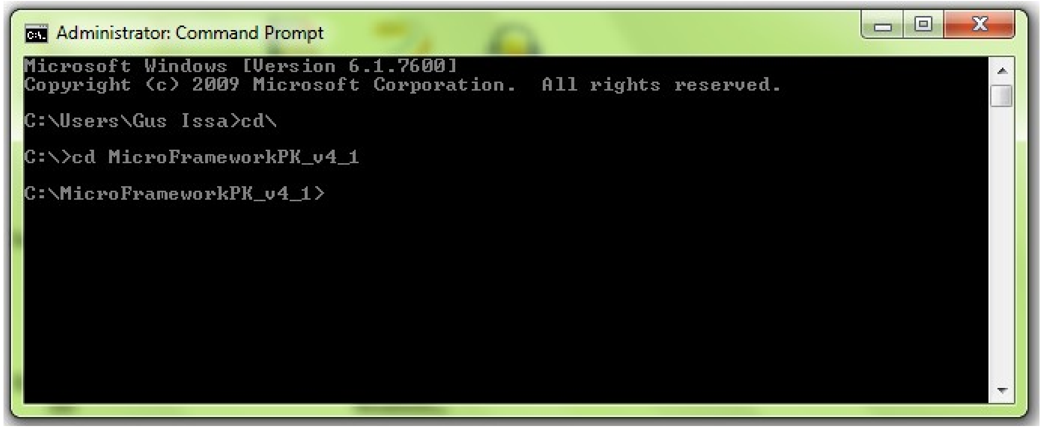
We are now ready to install the GCC tools. Keep all options to the default except for the install location, as shown above.

# 9. The PK Build System

If you are used to build simple projects using IDEs then you will not be very happy to know that you work with the NETMF source codes will be all done through command-line. With that said, the build system is really impressive. By running one command, the build system builds some tools (MetadataProcessor) that is used within the build itself! For this reason, the very first time you run a build, it will take a while to finish but, from that point on, the build finishes relatively fast.

Before we write a single line of code, we need to make sure we can build one of the ports that ship with the porting kit. I always select “iMXS” as my first test. This is the port that started NETMF and most used by NETMF developers. This port is also available in other form to demonstrate other features such as “iMXS_thumb” which shows how to build using THUMB instructions instead of ARM to reduce firmware footprint. In case you didn't know, ARM7 and ARM9 processors can run either 32-bit (ARM) instructions or 16-bit (THUMB) instructions. Using 16-bit will reduce performance very slightly but will make the memory requirements much less, so it is a good trade off for most applications.

Start by opening the command prompt, then access the PK folder



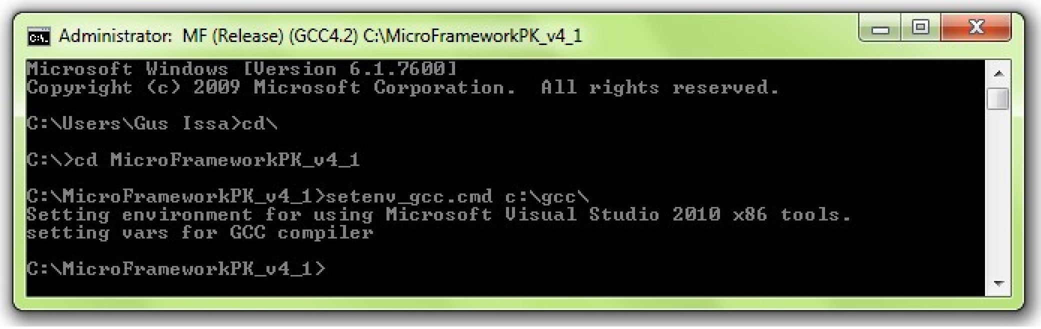
```
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\Gus Issa>cd\

C:\>cd MicroFrameworkPK_v4_1

C:\MicroFrameworkPK_v4_1>
```

We now set the environment to our compiler. If you are using one the supported compiler then this is one command, if you want to make this for your own compiler then expect long weeks of debugging. Note that there is no documentation anywhere on how this is done.

This is how the environment is set

setenv_gcc.cmd c:\gcc\

Note that I am assuming you did install the GCC compiler at c:\gcc as I suggested.

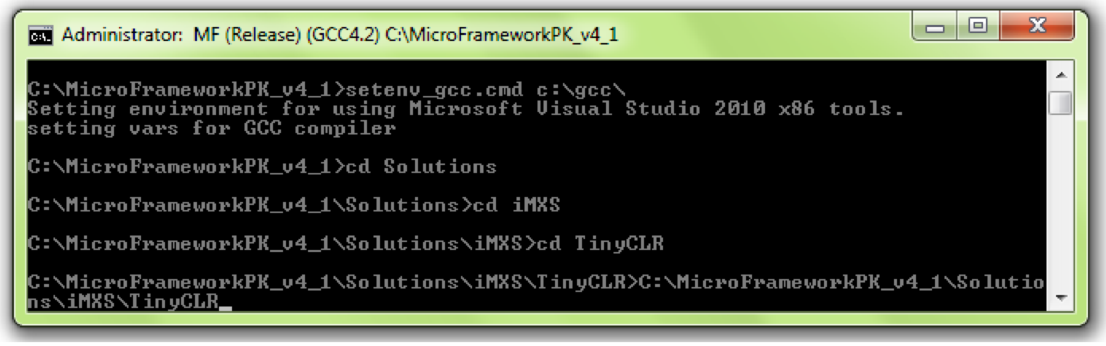

Administrator: MF (Release) (GCC4.2) C:\MicroFrameworkPK_v4_1

```
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\Gus Issa>cd\

C:\>cd MicroFrameworkPK_v4_1

C:\MicroFrameworkPK_v4_1>setenv_gcc.cmd c:\gcc\
Setting environment for using Microsoft Visual Studio 2010 x86 tools.
setting vars for GCC compiler

C:\MicroFrameworkPK_v4_1>
```

The next step is to build the iMXS solution to make sure our system is all set. At this point, you still haven't made any modifications to any file in the porting kit. This is important to track down any possible errors in the system setup.

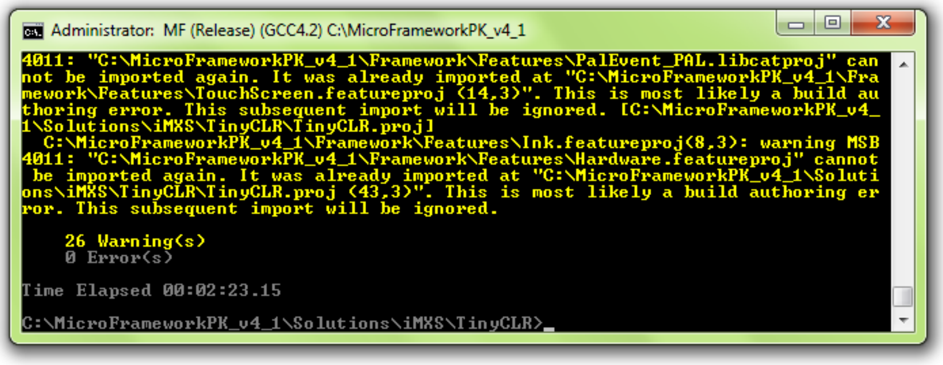
Access the C:\MicroFrameworkPK_v4_1\Solutions\iMXS\TinyCLR folder and run this command

MSBUILD.EXE  /t:build /p:flavor=release;memory=flash


Administrator: MF (Release) (GCC4.2) C:\MicroFrameworkPK_v4_1

```
C:\MicroFrameworkPK_v4_1>setenv_gcc.cmd c:\gcc\
Setting environment for using Microsoft Visual Studio 2010 x86 tools.
setting vars for GCC compiler

C:\MicroFrameworkPK_v4_1>cd Solutions

C:\MicroFrameworkPK_v4_1\Solutions>cd iMXS

C:\MicroFrameworkPK_v4_1\Solutions\iMXS>cd TinyCLR

C:\MicroFrameworkPK_v4_1\Solutions\iMXS\TinyCLR>C:\MicroFrameworkPK_v4_1\Solutio
ns\iMXS\TinyCLR_
```

You should see a lot of things happening in the prompt window and then you will have no errors at the end. This can take a while the first time you run this build.


Administrator: MF (Release) (GCC4.2) C:\MicroFrameworkPK_v4_1

```
4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\PalEvent_PAL.libcatproj" can
not be imported again. It was already imported at "C:\MicroFrameworkPK_v4_1\Fra
mework\Features\TouchScreen.featureproj (14,3)". This is most likely a build au
thoring error. This subsequent import will be ignored. [C:\MicroFrameworkPK_v4_
1\Solutions\iMXS\TinyCLR\TinyCLR.proj]
  C:\MicroFrameworkPK_v4_1\Framework\Features\Ink.featureproj(8,3): warning MSB
4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\Hardware.featureproj" cannot
 be imported again. It was already imported at "C:\MicroFrameworkPK_v4_1\Soluti
ons\iMXS\TinyCLR\TinyCLR.proj (43,3)". This is most likely a build authoring er
ror. This subsequent import will be ignored.

    26 Warning(s)
    0 Error(s)

Time Elapsed 00:02:23.15

C:\MicroFrameworkPK_v4_1\Solutions\iMXS\TinyCLR>_
```

When all is done and seem going perfectly, run the build a second time to see how much faster it will build. Now, let us assume you made some changes but things are not working as expected to you decided to run a clean build. This is easily accomplished using

```
MSBUILD.EXE  /t:clean /p:flavor=debug;memory=flash
```

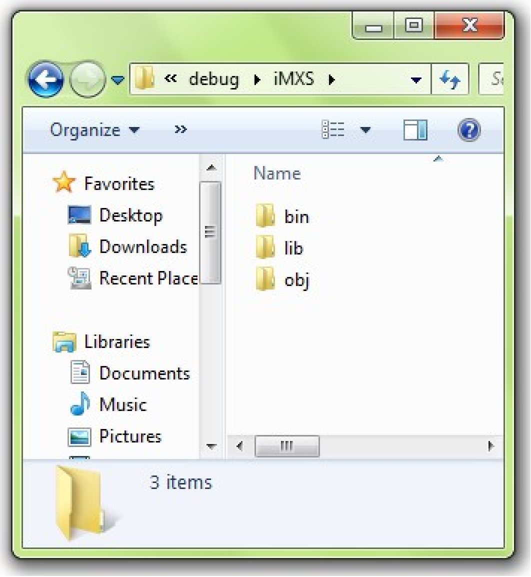
## 9.1. Output Folder

Each solution in the PK is built in a separate folder so you can easily make separate builds and not worry about possible errors.

For our example, the output folder is found at

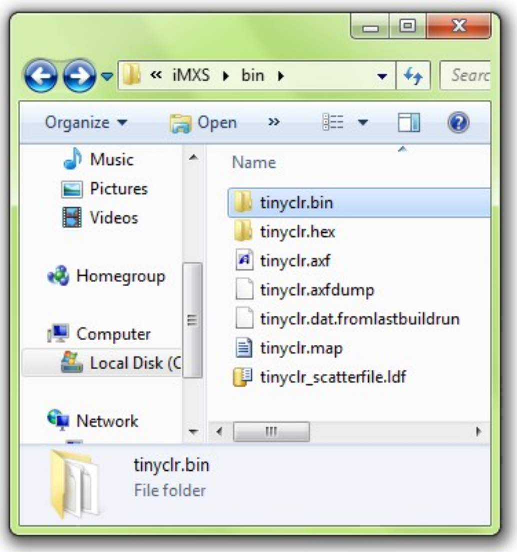
C:\MicroFrameworkPK_v4_1\BuildOutput\ARM\GCC4.2\le\FLASH\debug\iMXS

You will find 2 folders, bin, lib and obj



bin
lib
obj

The we are most interested in is the bin folder



tinyclr.bin
tinyclr.hex
tinyclr.axf
tinyclr.axfdump
tinyclr.dat.fromlastbuildrun
tinyclr.map
tinyclr_scatterfile.ldf

tinyclr.bin
File folder

In the folder, tinyclr.axf is an ELF file that contains all needed debugging info. This is the file you need if you were to use JTAG.

tinyclr.map lists where every method lives in memory. You will rarely use this file but when you need it you will be very happy to know it is there for you.

The tinyclr scatterfile.ldf is a very important file when we are starting a port and laying out memory. This is the file used by the linker to place object in their appropriate location. NETMF build system uses an XML file to layout the memory and then this file is generated using MetadataProcessor. It maybe useful to check this file to make sure the source XML file is correct.

Finally, and most importantly is the firmware. The firmware is generated in two forms, raw binary image and s-record file. The s-record file contains information on where the data should go in memory. Ideally, you will take the s-record file and use a chip programmer to place the firmware on the processor and then the processor will simply run it. So, you will always use the s-record file which is in tinyclr.hex folder. If you look in this folder you will see three files. All these file makeup the firmware but they are divided into separate regions. In the port we will be making in this book, I will only use one region.

A good use of the raw binary file is to determine how much flash is the firmware using.

# 10. FEZ Hacker Firmware

If you are using the DIY FEZ Hacker board then you are using the SAM7_EK port. All you need to do is compile it an load it, which should be simple.

Start by compiling the port as we did in last chapter. We compiled TinyCLR in last chapter but we also want to compile TinyBooter for this port. GHI didn't use TinyBooter on its low-end NETMF devices to save on memory but this SAM port uses TinyBooter.

## 10.1. Building Steps

### Build TinyBooterDecompressor

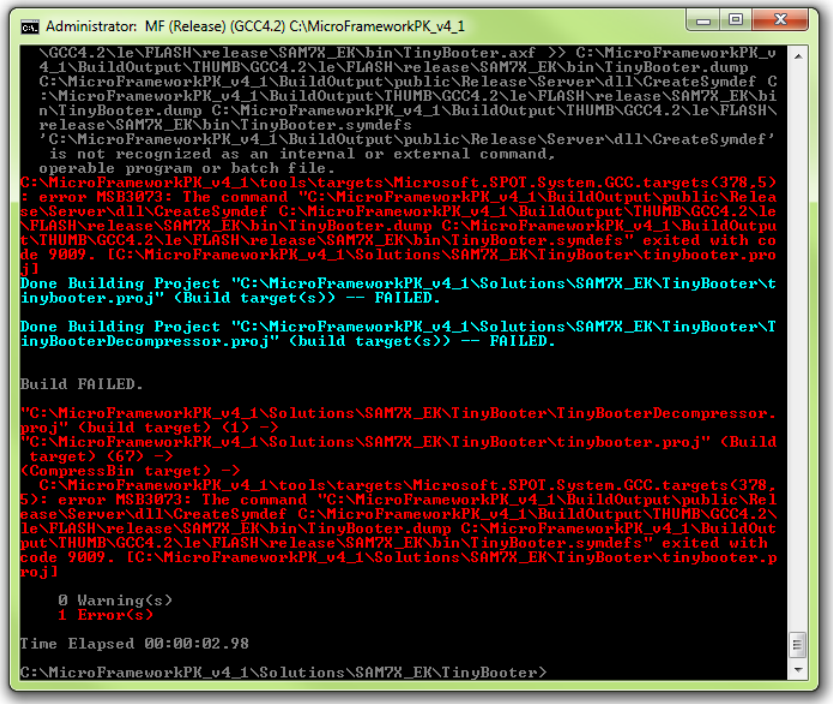
MSBUILD TinyBooterDecompressor.proj /t:build /p:flavor=release;memory=flash

If the build completed with an error saying something about ”CreateSymdef” then copy CreateSymdef.exe file from

C:\MicroFrameworkPK_v4_1\tools\bin to

C:\MicroFrameworkPK_v4_1\BuildOutput\public\Release\Server\dll

This is a sample of the error message

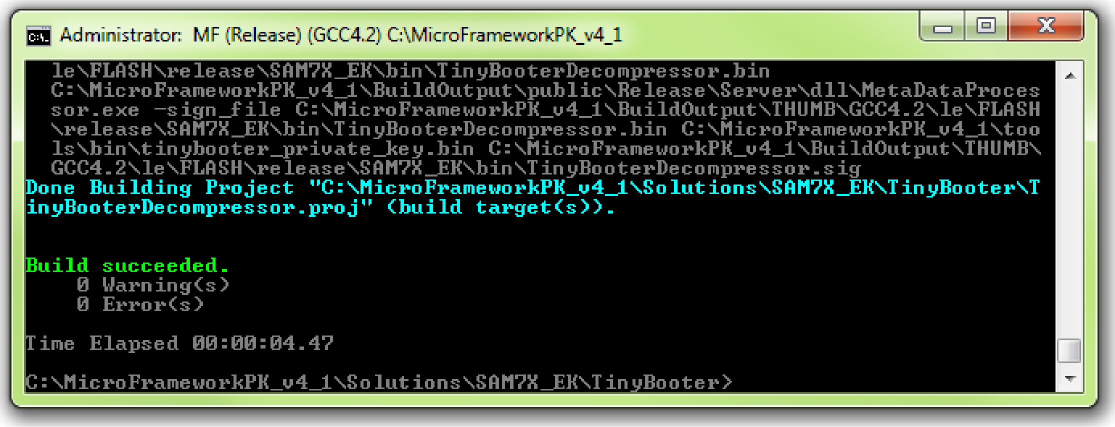


Administrator: MF (Release) (GCC4.2) C:\MicroFrameworkPK_v4_1

```
  \GCC4.2\le\FLASH\release\SAM7X_EK\bin\TinyBooter.axf  >> C:\MicroFrameworkPK_v
  4_1\BuildOutput\THUMB\GCC4.2\le\FLASH\release\SAM7X_EK\bin\TinyBooter.dump
  C:\MicroFrameworkPK_v4_1\BuildOutput\public\Release\Server\dll\CreateSymdef C
  :\MicroFrameworkPK_v4_1\BuildOutput\THUMB\GCC4.2\le\FLASH\release\SAM7X_EK\bi
  n\TinyBooter.dump C:\MicroFrameworkPK_v4_1\BuildOutput\THUMB\GCC4.2\le\FLASH\
  release\SAM7X_EK\bin\TinyBooter.symdefs
  'C:\MicroFrameworkPK_v4_1\BuildOutput\public\Release\Server\dll\CreateSymdef'
   is not recognized as an internal or external command,
  operable program or batch file.
C:\MicroFrameworkPK_v4_1\tools\targets\Microsoft.SPOT.System.GCC.targets(378,5)
: error MSB3073: The command "C:\MicroFrameworkPK_v4_1\BuildOutput\public\Relea
se\Server\dll\CreateSymdef C:\MicroFrameworkPK_v4_1\BuildOutput\THUMB\GCC4.2\le
\FLASH\release\SAM7X_EK\bin\TinyBooter.dump C:\MicroFrameworkPK_v4_1\BuildOutpu
t\THUMB\GCC4.2\le\FLASH\release\SAM7X_EK\bin\TinyBooter.symdefs" exited with co
de 9009. [C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter\tinybooter.pro
j]
Done Building Project "C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter\t
inybooter.proj" (Build target(s)) -- FAILED.

Done Building Project "C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter\T
inyBooterDecompressor.proj" (build target(s)) -- FAILED.


Build FAILED.

"C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter\TinyBooterDecompressor.
proj" (build target) (1) ->
"C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter\tinybooter.proj" (Build
 target) (67) ->
(CompressBin target) ->
  C:\MicroFrameworkPK_v4_1\tools\targets\Microsoft.SPOT.System.GCC.targets(378,
5): error MSB3073: The command "C:\MicroFrameworkPK_v4_1\BuildOutput\public\Rel
ease\Server\dll\CreateSymdef C:\MicroFrameworkPK_v4_1\BuildOutput\THUMB\GCC4.2\
le\FLASH\release\SAM7X_EK\bin\TinyBooter.dump C:\MicroFrameworkPK_v4_1\BuildOut
put\THUMB\GCC4.2\le\FLASH\release\SAM7X_EK\bin\TinyBooter.symdefs" exited with
code 9009. [C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter\tinybooter.p
roj]

    0 Warning(s)
    1 Error(s)

Time Elapsed 00:00:02.98

C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter>
```

Then try to build again if needed and make sure you have no errors at the end.

Here is the build completed with no errors.

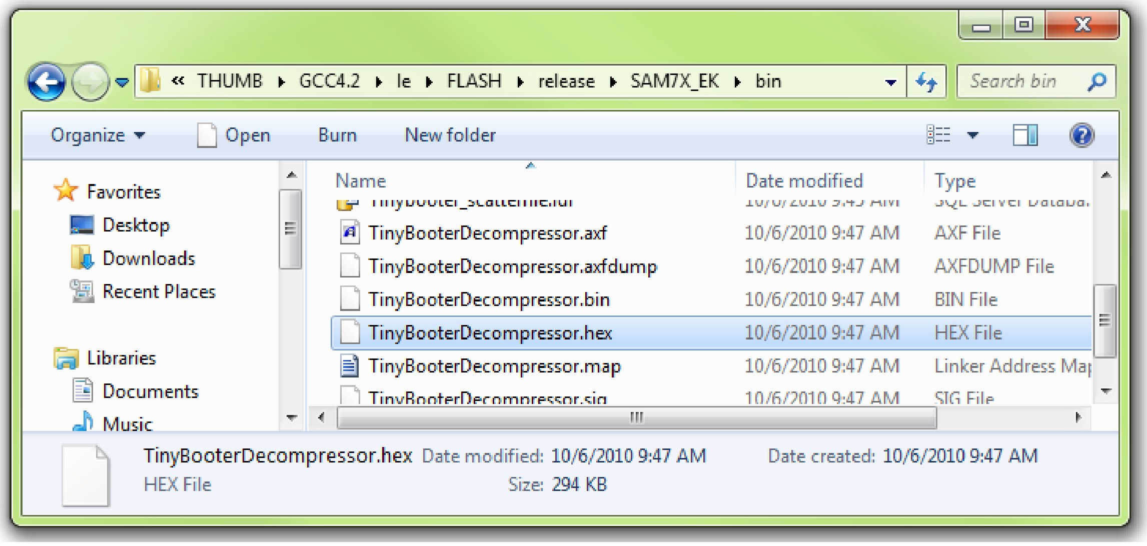

Administrator: MF (Release) (GCC4.2) C:\MicroFrameworkPK_v4_1

```
   le\FLASH\release\SAM7X_EK\bin\TinyBooterDecompressor.bin
   C:\MicroFrameworkPK_v4_1\BuildOutput\public\Release\Server\dll\MetaDataProces
   sor.exe -sign_file C:\MicroFrameworkPK_v4_1\BuildOutput\THUMB\GCC4.2\le\FLASH
   \release\SAM7X_EK\bin\TinyBooterDecompressor.bin C:\MicroFrameworkPK_v4_1\too
   ls\bin\tinybooter_private_key.bin C:\MicroFrameworkPK_v4_1\BuildOutput\THUMB\
   GCC4.2\le\FLASH\release\SAM7X_EK\bin\TinyBooterDecompressor.sig
Done Building Project "C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter\T
inyBooterDecompressor.proj" (build target(s)).

Build succeeded.
    0 Warning(s)
    0 Error(s)

Time Elapsed 00:00:04.47

C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyBooter>
```

The output folder is located at

C:\MicroFrameworkPK_v4_1\BuildOutput\THUMB\GCC4.2\le\FLASH\release\SAM7X_EK\bin

It should have plenty of files but you are specifically interested in TinyBooterDecompressor.hex and TinyBooterDecompressor.bin



| Name | Date modified | Type |
|---|---|---|
| TinyBooterDecompressor.axf | 10/6/2010 9:47 AM | AXF File |
| TinyBooterDecompressor.axfdump | 10/6/2010 9:47 AM | AXFDUMP File |
| TinyBooterDecompressor.bin | 10/6/2010 9:47 AM | BIN File |
| TinyBooterDecompressor.hex | 10/6/2010 9:47 AM | HEX File |
| TinyBooterDecompressor.map | 10/6/2010 9:47 AM | Linker Address Ma |
| TinyBooterDecompressor.sig | 10/6/2010 9:47 AM | SIG File |

TinyBooterDecompressor.hex Date modified: 10/6/2010 9:47 AM Date created: 10/6/2010 9:47 AM
HEX File Size: 294 KB

You are now ready to load the firmware

# 10.2. SAM-BA

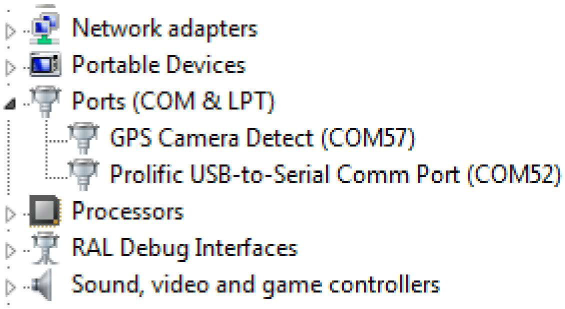
SAM-BA is a free software from Atmel that is used to load firmware on Atmel ARM chips using USB. Download and install SAM-BA from

http://www.atmel.com/dyn/resources/prod_documents/sam-ba_2.10.exe

If the link didn't work then search Atmel website for SAM-BA

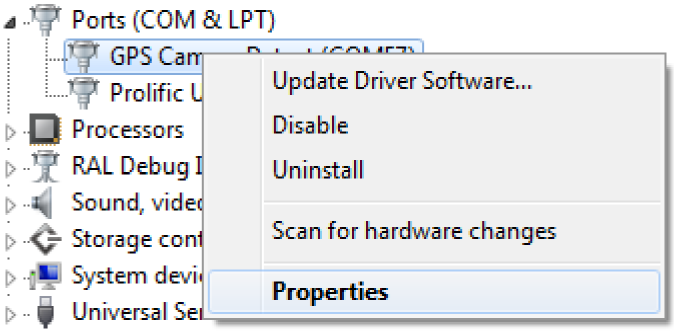
**Note: If you are not sure if your chip is erased, short the "Erase" jumper and power the board for 1 second then disconnect power and remove the jumper.**

Now, plug in your FEZ Hacker to the PC, windows will ask for drivers. Windows will probably see it as "GPS Camera Detect". Do not worry about the name and take a note of the com port number, mine is COM57

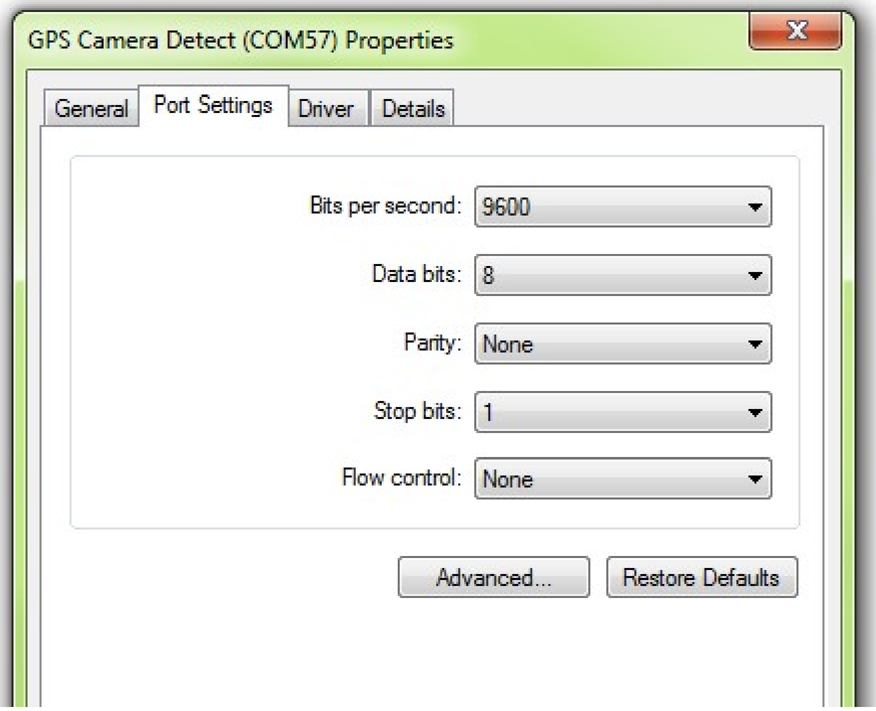

Network adapters
Portable Devices
Ports (COM & LPT)
GPS Camera Detect (COM57)
Prolific USB-to-Serial Comm Port (COM52)
Processors
RAL Debug Interfaces
Sound, video and game controllers

If windows was not able to locate the drivers on its own, direct windows to ChipworkX loader drivers in the GHI SDK found at C:\Program Files (x86)\GHI Electronics\GHI NETMF v4.1 SDK\ChipworkX\Firmware\TinyBooter Updater\USB Tinybooter Updater driver

Loading the driver will create a new virtual serial port on windows. You can now start SAM-BA and select the appropriate board and COM port. Note that running SAM-BA can take minutes, thanks Atmel!! Another problem is that this software doesn't seem to work with high COM port numbers so we need to change our COM port number to something lower than 9. You can use any COM as long as it is not used already. I do not have any under 9 in my list so I will just use COM4. You can change the COM number as follows



Right click the device and select "Properties" then from the "Port Settings" click "Advanced..."



GPS Camera Detect (COM57) Properties

Bits per second: 9600

Data bits: 8

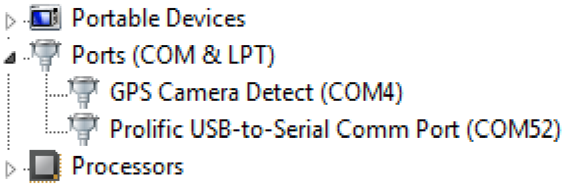
Parity: None

Stop bits: 1

Flow control: None

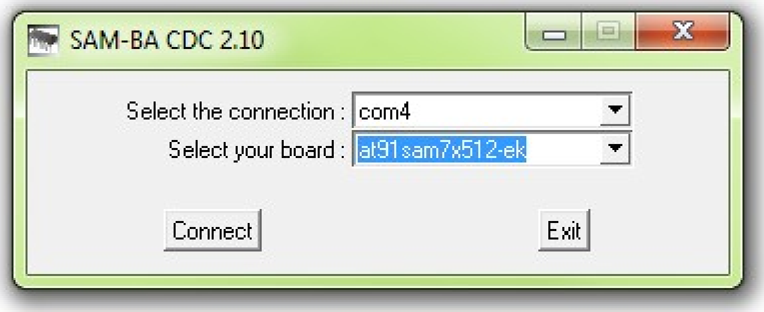
Although windows telling me it is “in use”, I know it is not connected right now so I will go ahead and use COM4. Click OK and then disconnect and reconnect your FEZ Hacker board.

My port is now COM4



Portable Devices
Ports (COM & LPT)
GPS Camera Detect (COM4)
Prolific USB-to-Serial Comm Port (COM52)
Processors

We can now run SAM-BA software. If you had it open then you will have to close it and reopen it.



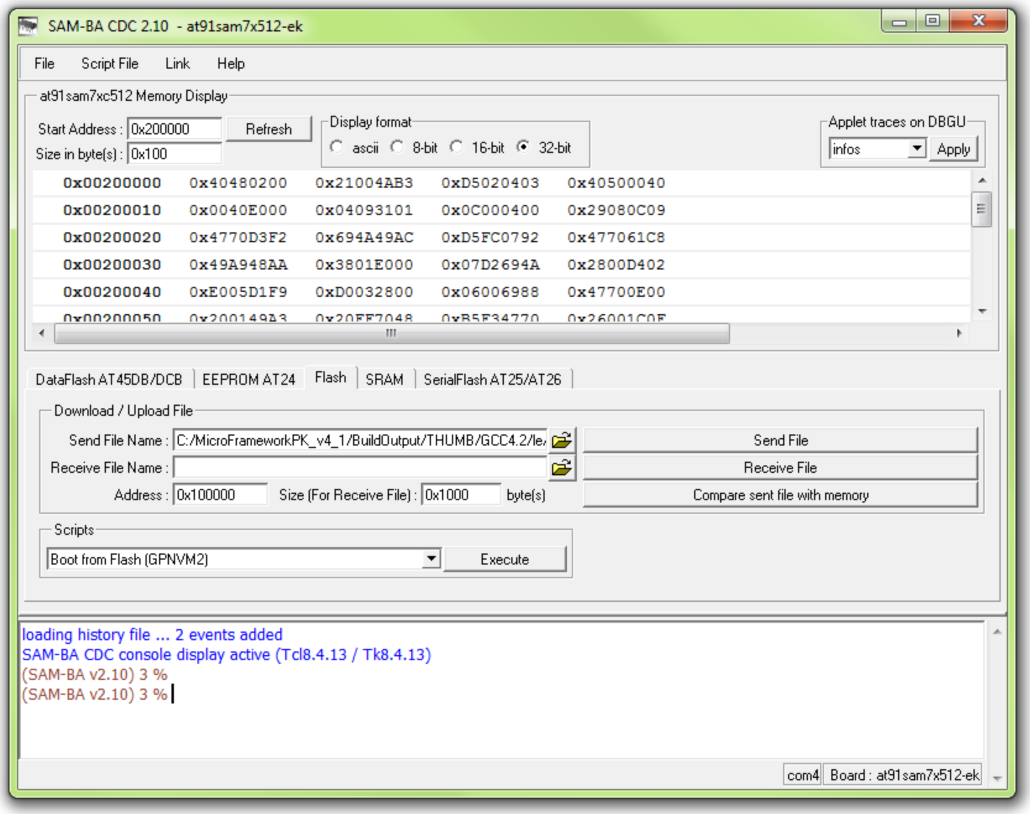
SAM-BA CDC 2.10

Select the connection : com4

Select your board : at91sam7x512-ek

Remember how our board is compatible with AT91SAM7X512-EK board? We basically just copied the schematics. So, we will use that option from the menu. Also select the appropriate COM port, mine was forced to COM4 in previous steps.

Click connect and you will have a new dialog. From the "Flash" menu, direct SAM-BA to TinyBooterDecompressor.bin file and click "SendFile"



Start Address : 0x200000
Size in byte(s) : 0x100
Display format: ○ ascii ○ 8-bit ○ 16-bit ● 32-bit
Applet traces on DBGU: infos

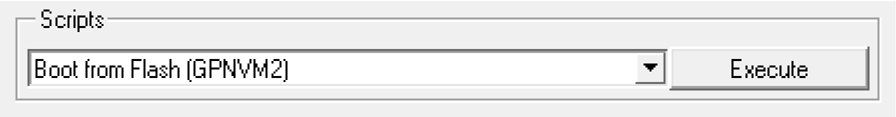
```
0x00200000   0x40480200   0x21004AB3   0xD5020403   0x40500040
0x00200010   0x0040E000   0x04093101   0x0C000400   0x29080C09
0x00200020   0x4770D3F2   0x694A49AC   0xD5FC0792   0x477061C8
0x00200030   0x49A948AA   0x3801E000   0x07D2694A   0x2800D402
0x00200040   0xE005D1F9   0xD0032800   0x06006988   0x47700E00
0x00200050   0x200149A3   0x20FF7048   0xB5F34770   0x26001C0F
```

Send File Name : C:/MicroFrameworkPK_v4_1/BuildOutput/THUMB/GCC4.2/le/
Receive File Name :
Address : 0x100000 Size (For Receive File) : 0x1000 byte(s)
Scripts: Boot from Flash (GPNVM2)

```
loading history file ... 2 events added
SAM-BA CDC console display active (Tcl8.4.13 / Tk8.4.13)
(SAM-BA v2.10) 3 %
(SAM-BA v2.10) 3 %
```

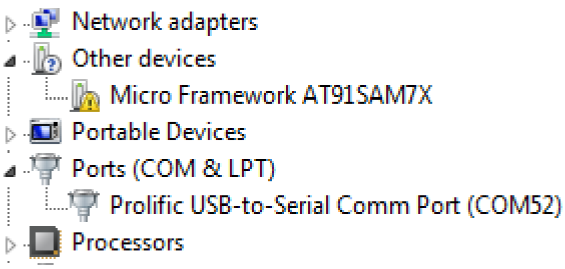
com4 Board : at91sam7x512-ek

Now that TinyBooter is loaded, we can run the script "Boot from Flash", hit Execute.



Boot from Flash (GPNVM2)

When done, close SAM-BA and reset the board. This time windows will see the device as a NETMF device and will start looking for drivers. Windows will fail to locate drivers at the end since you do not have drivers just yet.

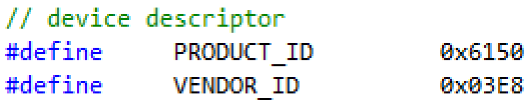


- Network adapters
- Other devices
  - Micro Framework AT91SAM7X
- Portable Devices
- Ports (COM & LPT)
  - Prolific USB-to-Serial Comm Port (COM52)
- Processors

GHI has its own USB VID (Vendor ID) and that what it uses for its devices. The SAM port you built uses some random VID but it is not GHI's. To make the GHI drivers work, you have 2 options. Either change the VID in source codes to the GHI's VID or change the VID in the GHI USB drivers to match what is used in the SAM port. The problem with the second option is that you will lose the digital signing if you make any changes on the USB drivers. So, we will change the VID in the SAM port source codes to use GHI's.

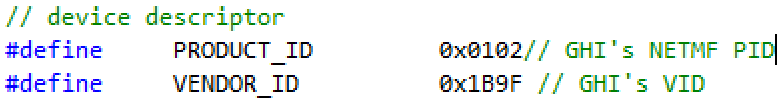
Open "usb_config.cpp" file located at
C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\DeviceCode\USB

Find the VID and PID



```
// device descriptor
#define     PRODUCT_ID          0x6150
#define     VENDOR_ID           0x03E8
```

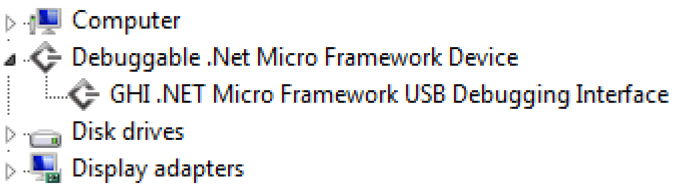
and change them to same ones used by GHI, VID 1B9F and PID 0102



```
// device descriptor
#define     PRODUCT_ID          0x0102// GHI's NETMF PID
#define     VENDOR_ID           0x1B9F // GHI's VID
```

We can now rebuild and deploy just like we did before, just remember to erase FEZ Hacker first using the "Erase" jumper.

When all is done, you will see this in your "Device Manager"

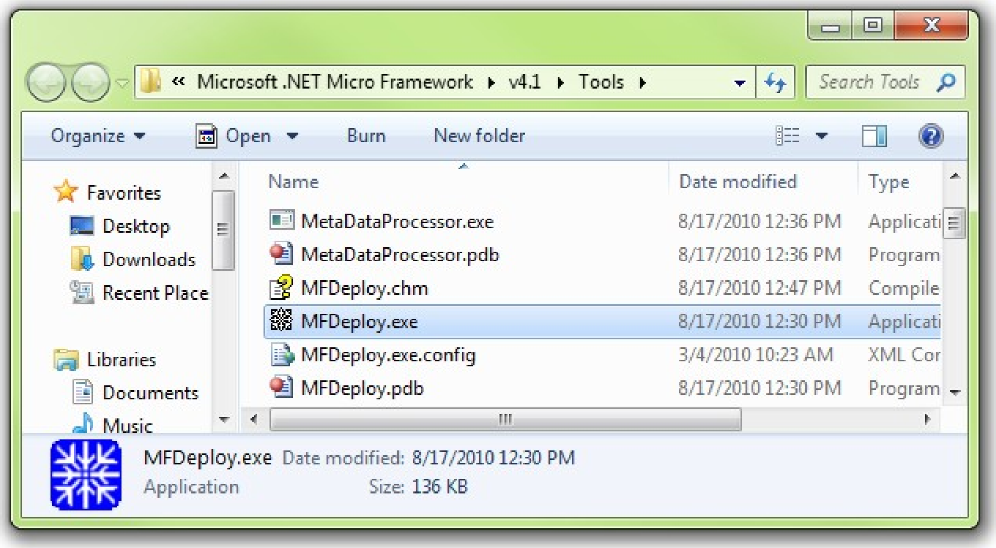


- Computer
- Debuggable .Net Micro Framework Device
  - GHI .NET Micro Framework USB Debugging Interface
- Disk drives
- Display adapters

We have now a device that is booted with TinyBooter. I told you NETMF doesn't have to be difficult.

# 10.3. MFDeploy

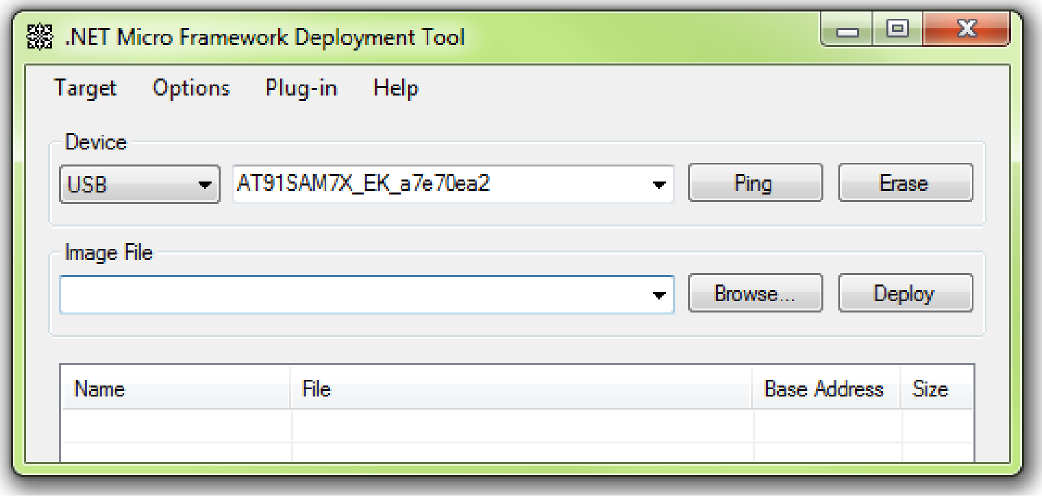
MFDeploy has many uses in NETMF. We will use it to load the firmware fro now. Locate and run MFDeploy



| Name | Date modified | Type |
|---|---|---|
| MetaDataProcessor.exe | 8/17/2010 12:36 PM | Applicati |
| MetaDataProcessor.pdb | 8/17/2010 12:36 PM | Program |
| MFDeploy.chm | 8/17/2010 12:47 PM | Compile |
| MFDeploy.exe | 8/17/2010 12:30 PM | Applicati |
| MFDeploy.exe.config | 3/4/2010 10:23 AM | XML Cor |
| MFDeploy.pdb | 8/17/2010 12:30 PM | Program |

MFDeploy.exe Date modified: 8/17/2010 12:30 PM
Application Size: 136 KB

Select USB and you will see AT91SAM7X_EK showing up in the the device list.



Device
USB
AT91SAM7X_EK_a7e70ea2

Image File

| Name | File | Base Address | Size |
|---|---|---|---|

Click “Ping” and the device should respond

```
Pinging... TinyBooter
Bootloader build info: Microsoft Copyright (C) Microsoft
Corporation.  All rig
```

We are almost done, just build TinyCLR and load it using MFDeploy.

The build step is simple but first we have to make a little modification.

Locate C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyCLR folder and open TinyCLR.proj

This is an XML file so you can open it with Visual Studio, just drag and drop it in it.

Now find this line and delete it

```
<MultipleOutputSections Condition="'$(MEMORY)'=='FLASH'">true</MultipleOutputSections>
```

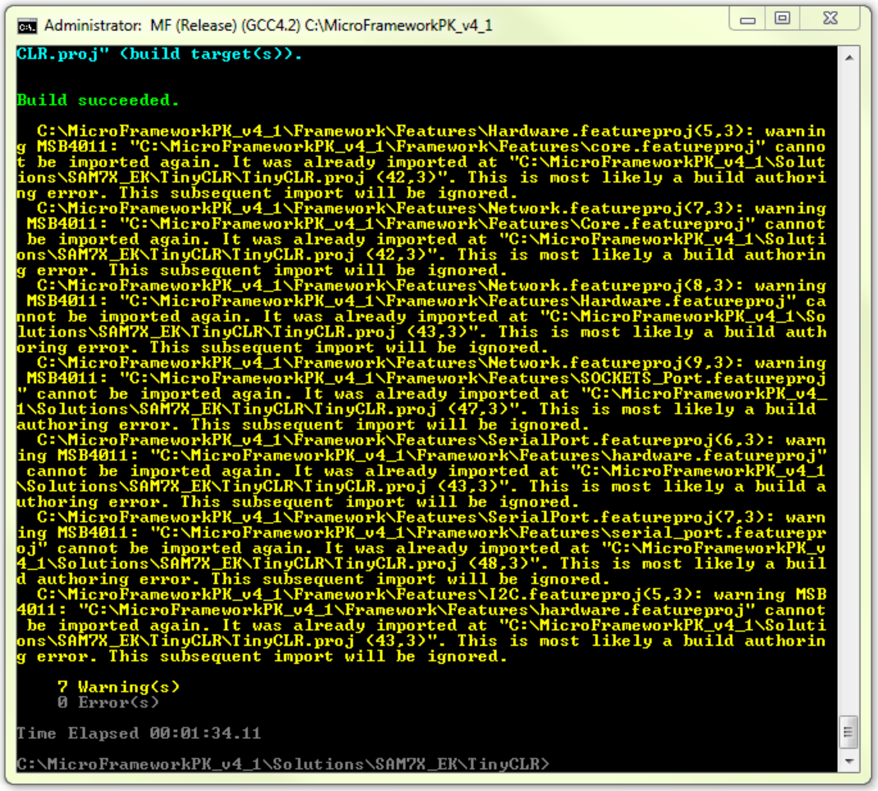
Save and close TinyCLR.proj file

Finally, access TinyCLR folder and run

C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK>

MSBUILD /t:build /p:flavor=release;memory=flash

You may have some warning at the end but need to make sure that we have no errors.



Administrator: MF (Release) (GCC4.2) C:\MicroFrameworkPK_v4_1

```
CLR.proj" (build target(s)).


Build succeeded.

  C:\MicroFrameworkPK_v4_1\Framework\Features\Hardware.featureproj(5,3): warnin
g MSB4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\core.featureproj" canno
t be imported again. It was already imported at "C:\MicroFrameworkPK_v4_1\Solut
ions\SAM7X_EK\TinyCLR\TinyCLR.proj (42,3)". This is most likely a build authori
ng error. This subsequent import will be ignored.
  C:\MicroFrameworkPK_v4_1\Framework\Features\Network.featureproj(7,3): warning
 MSB4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\Core.featureproj" cannot
 be imported again. It was already imported at "C:\MicroFrameworkPK_v4_1\Soluti
ons\SAM7X_EK\TinyCLR\TinyCLR.proj (42,3)". This is most likely a build authorin
g error. This subsequent import will be ignored.
  C:\MicroFrameworkPK_v4_1\Framework\Features\Network.featureproj(8,3): warning
 MSB4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\Hardware.featureproj" ca
nnot be imported again. It was already imported at "C:\MicroFrameworkPK_v4_1\So
lutions\SAM7X_EK\TinyCLR\TinyCLR.proj (43,3)". This is most likely a build auth
oring error. This subsequent import will be ignored.
  C:\MicroFrameworkPK_v4_1\Framework\Features\Network.featureproj(9,3): warning
 MSB4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\SOCKETS_Port.featureproj
" cannot be imported again. It was already imported at "C:\MicroFrameworkPK_v4_
1\Solutions\SAM7X_EK\TinyCLR\TinyCLR.proj (47,3)". This is most likely a build
authoring error. This subsequent import will be ignored.
  C:\MicroFrameworkPK_v4_1\Framework\Features\SerialPort.featureproj(6,3): warn
ing MSB4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\hardware.featureproj"
 cannot be imported again. It was already imported at "C:\MicroFrameworkPK_v4_1
\Solutions\SAM7X_EK\TinyCLR\TinyCLR.proj (43,3)". This is most likely a build a
uthoring error. This subsequent import will be ignored.
  C:\MicroFrameworkPK_v4_1\Framework\Features\SerialPort.featureproj(7,3): warn
ing MSB4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\serial_port.featurepr
oj" cannot be imported again. It was already imported at "C:\MicroFrameworkPK_v
4_1\Solutions\SAM7X_EK\TinyCLR\TinyCLR.proj (48,3)". This is most likely a buil
d authoring error. This subsequent import will be ignored.
  C:\MicroFrameworkPK_v4_1\Framework\Features\I2C.featureproj(5,3): warning MSB
4011: "C:\MicroFrameworkPK_v4_1\Framework\Features\hardware.featureproj" cannot
 be imported again. It was already imported at "C:\MicroFrameworkPK_v4_1\Soluti
ons\SAM7X_EK\TinyCLR\TinyCLR.proj (43,3)". This is most likely a build authorin
g error. This subsequent import will be ignored.

    7 Warning(s)
    0 Error(s)

Time Elapsed 00:01:34.11

C:\MicroFrameworkPK_v4_1\Solutions\SAM7X_EK\TinyCLR>
```

Back to MFDeploy, select TinyCLR.hex file from the output folder and click Deploy. This will take a while! By the way, this runs much faster on other FEZ boards.

When done, click Ping and you will see TinyCLR instead of TinyBooter

```
Pinging... TinyCLR
```

We can now use Visual Studio to blink an LED or do whatever we like. If not sure how, use the other free “Beginner Guide to NETMF” ebook for details on using NETMF. This book only covers porting. Here is an example on blinking an LED, which is connected to PA7 (that is IO7).

```
using System;
using System.Threading;
using Microsoft.SPOT;
using Microsoft.SPOT.Hardware;

namespace MFConsoleApplication1
{
    public class Program
    {
        public static void Main()
        {
            OutputPort LED = new OutputPort(Cpu.Pin.GPIO_Pin7, true);

            while (true)
            {
                Thread.Sleep(500);
                LED.Write(false);
                Thread.Sleep(500);
                LED.Write(true);

            }
        }

    }
}
```

# 11. Hardware Setup

I have selected FEZ Panda since it is the smallest device GHI offers and it is all open source. You may need to buy two FEZ Panda's, one pre-programmed and one you can erase as explained below.

## 11.1. USBizi Firmware

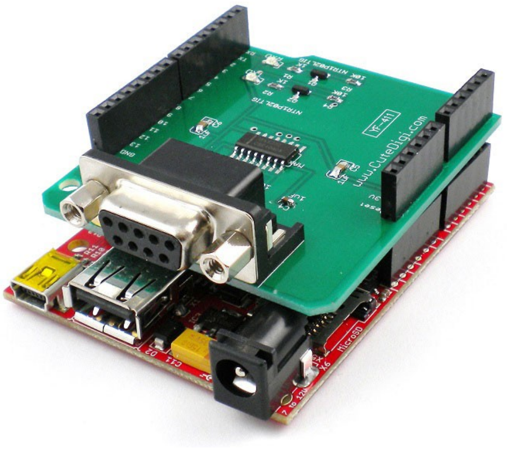
By default, FEZ Panda (and Rhino, Domino, Mini...) ship with GHI's USBizi firmware. This firmware has a lot of exclusive features not found any any NETMF device. GHI does all the maintenance, testing and upgrades free of any charge. The firmware also ship with a superior support and is maintained to have commercial quality.

Now, if you select to compile your own NETMF firmware, this book will get you started but note that, while the GHI staff is very helpful, GHI is not required to provide free porting support. You are free to use the GHI forums to ask questions. You may also use the forums at http://www.netmf.com/

## 11.2. Adding RS232

When porting NETMF, it is essential to use the most basic form of deployment. Since the options are UART, USB and Ethernet, it is obvious that UART is the choice. Since PC's serial ports are RS232 levels and the UART is TTL level, a little circuitry is required to shift the voltage levels from TTL to RS232. The easiest way to do this is by adding the RS232 shield on FEZ Panda.

Another option is to use the the FTDI TTL cables. I will be using the shield in my testing.



## 11.3. Using FEZ Panda

Before trying to port, you may want to get yourself familiar with FEZ Panda through the USBizi firmware that it ships with. For example, make sure that your RS232 connection is well established. Maybe ground the MODE pin and try to deploy over RS232 (COM) and make sure you can blink the on-board LED. You can use my other book to learn more about using NETMF.

## 11.4. Erasing FEZ Panda

The next step is to erase FEZ Panda. Once FEZ Panda is erased **you can NOT put the USBizi firmware back** on it. Basically, once FEZ Panda is erased, it becomes a board with LPC2387 ARM processor. Support from GHI is optional but GHI provides the EAGLE design files and PDF schematics, all open source. If you need to load USBizi official firmware back on FEZ Panda board, you must send the board back to GHI (not distributor) to have it reflashed.

Once you are sure you want to void the warranty and erase your FEZ Panda, you can follow these steps **(you can't restore USBizi firmware once it is erased)**:

1. Download this file http://www.tinyclr.com/downloads/Porting/Do_NOT_use_will_erase_firmware.GHI
2. Make sure you are using UART, NOT USB, for accessing the FEZ Panda loader.
3. Open TeraTerm and do “erase all” (see USBizi user manual)
4. Load the above file the same way you load USBizi firmware.
5. When done, you will see some messages on TeraTerm as showing in image below, you will need to confirm you want the firmware erased.

**** image ***

## 11.5. Loading Test Application

Now that the board is erased, you can now load anything you want on FEZ Panda. The JTAG is now also unlocked so debugging is also possible if you want to use it.

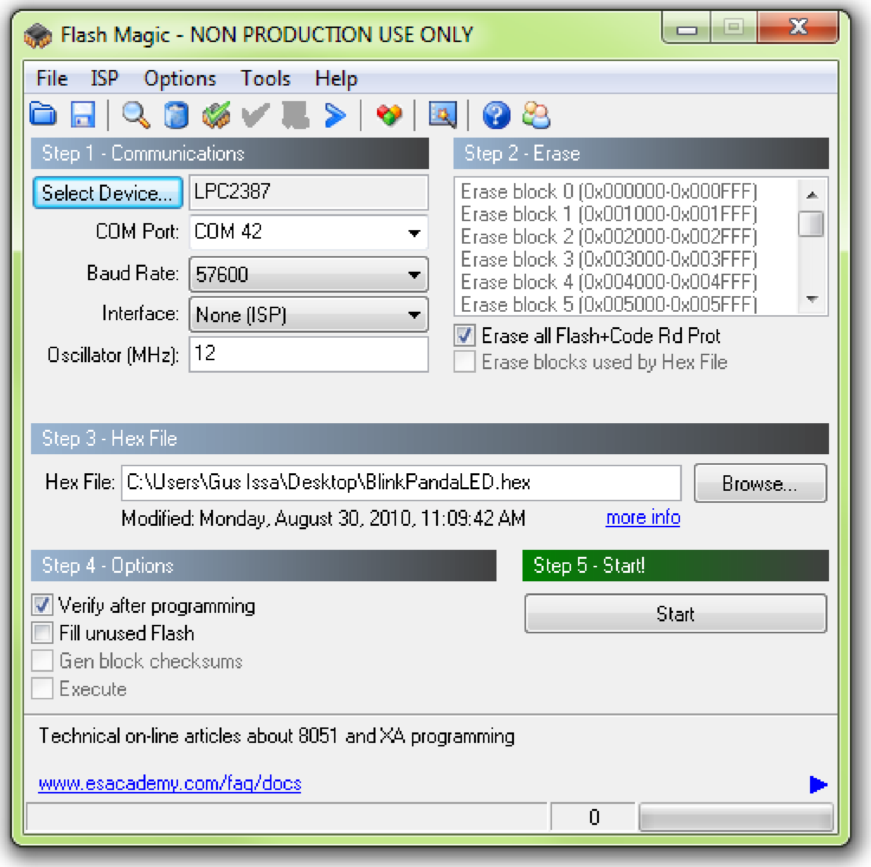
I will assume you do not have JTAG and we will load flash using a tool called Flash Magic. In this stage, we will load a hex file that blinks an LED. This will test out that Flash Magic and the NXP boot loader is working as expected. Remember how I said you need UART? The NXP loader only works on UART.

Loading hex files on NXP chips is easy but can be tricky so please follow these steps. We will start by connecting TeraTerm at 9600 baud, not 115200. Then enter “?”, without quotes. FEZ Panda should return “Synchronized” as shown in image below.

**image**

Now, download the LED blink application from http://www.tinyclr.com/downloads/Porting/BlinkPandaLED.hex

We will use Flash Magic to load this file. Make sure you configure the tool as showing in the image below, the baud rate must be 57600. The COM port number is whatever is the COM port you are using to communicate with FEZ Panda



Step 1 - Communications

Select Device... LPC2387

COM Port: COM 42

Baud Rate: 57600

Interface: None (ISP)

Oscillator (MHz): 12

Step 2 - Erase

Erase block 0 (0x000000-0x000FFF)
Erase block 1 (0x001000-0x001FFF)
Erase block 2 (0x002000-0x002FFF)
Erase block 3 (0x003000-0x003FFF)
Erase block 4 (0x004000-0x004FFF)
Erase block 5 (0x005000-0x005FFF)

☑ Erase all Flash+Code Rd Prot
☐ Erase blocks used by Hex File

Step 3 - Hex File

Hex File: C:\Users\Gus Issa\Desktop\BlinkPandaLED.hex

Modified: Monday, August 30, 2010, 11:09:42 AM

Step 4 - Options

☑ Verify after programming
☐ Fill unused Flash
☐ Gen block checksums
☐ Execute

Step 5 - Start!

Technical on-line articles about 8051 and XA programming

www.esacademy.com/faq/docs

0

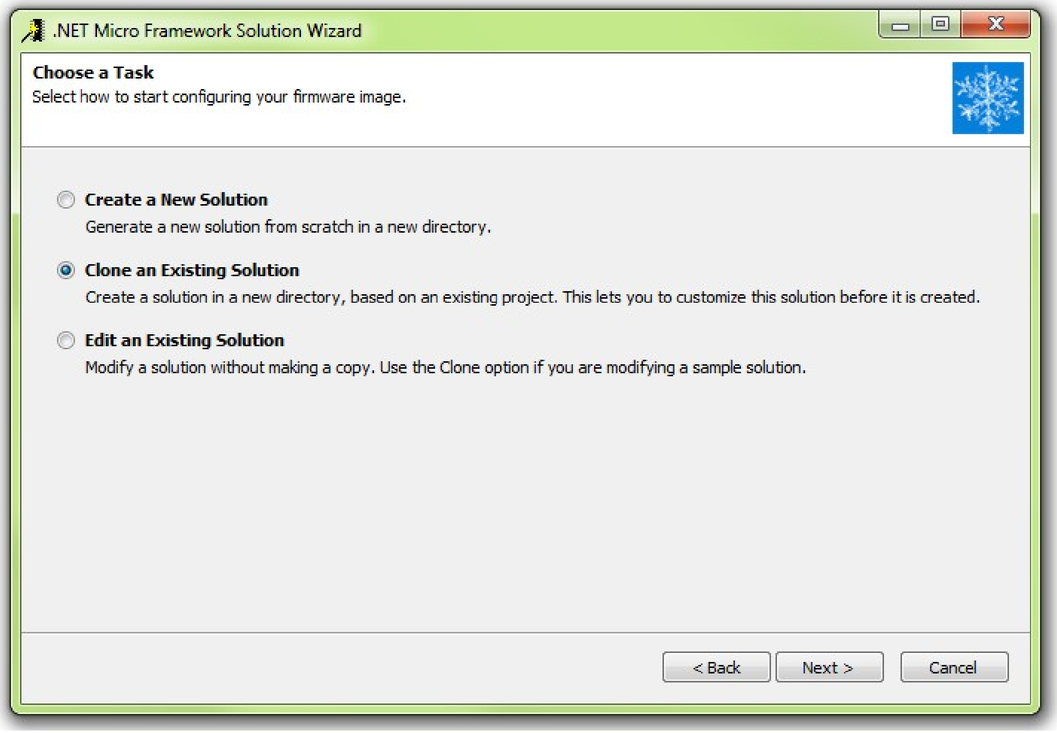
If loading failed, click reset on FEZ Panda and try again. Once loading complete, reset the FEZ Panda and the LED should be blinking. Note that the LED is blinking using a simple compiled C program, not using NETMF. We erased NETMF in the previous step.

We are now ready to compile NETMF and load on FEZ Panda, excited yet?!

# 12. Solution Wizard

The NETMF porting kit ships with a tool called “Solution Wizard” that can be used to add or remove components for your NETMF porting solution. The solution wizard is perfect for cloning a solutions. If this is your first port, you do not want to start from scratch. Instead, clone one of the ports and then start modifying it.

FEZ Panda uses LPC2387 processor and there is no such port it the porting kit. On the other hand, the porting kit includes LPC2478 which has almost the same peripherals. First, make sure you can compile the LPC2478 solution as explained earlier in this book. Next, clone the solution.



**Choose a Task**

Select how to start configuring your firmware image.

○ **Create a New Solution**

Generate a new solution from scratch in a new directory.

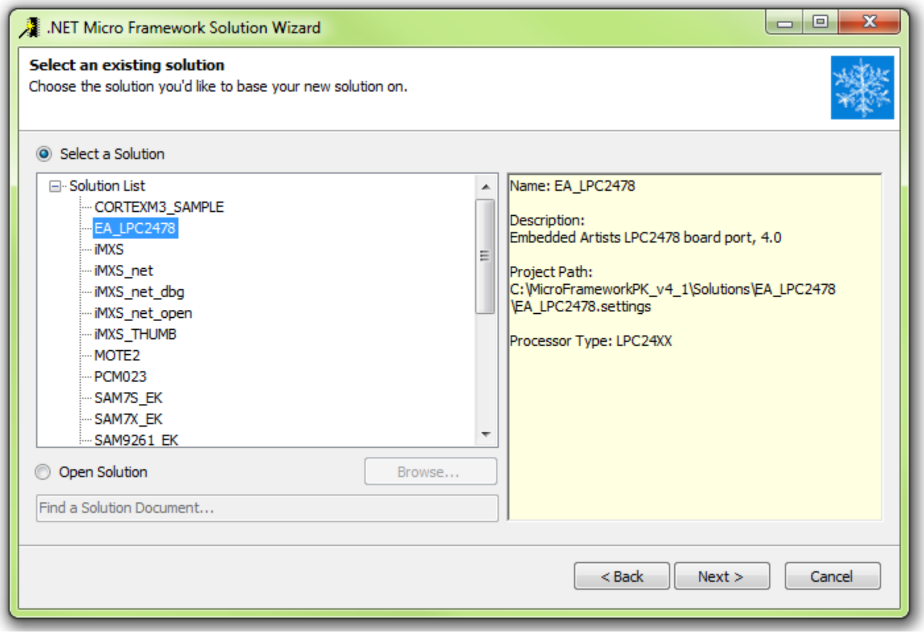
● **Clone an Existing Solution**

Create a solution in a new directory, based on an existing project. This lets you to customize this solution before it is created.

○ **Edit an Existing Solution**

Modify a solution without making a copy. Use the Clone option if you are modifying a sample solution.

Select EA_LPC2478



.NET Micro Framework Solution Wizard

**Select an existing solution**

Choose the solution you'd like to base your new solution on.

● Select a Solution

Solution List
- CORTEXM3_SAMPLE
- EA_LPC2478
- iMXS
- iMXS_net
- iMXS_net_dbg
- iMXS_net_open
- iMXS_THUMB
- MOTE2
- PCM023
- SAM7S_EK
- SAM7X_EK
- SAM9261_EK

Name: EA_LPC2478

Description:
Embedded Artists LPC2478 board port, 4.0

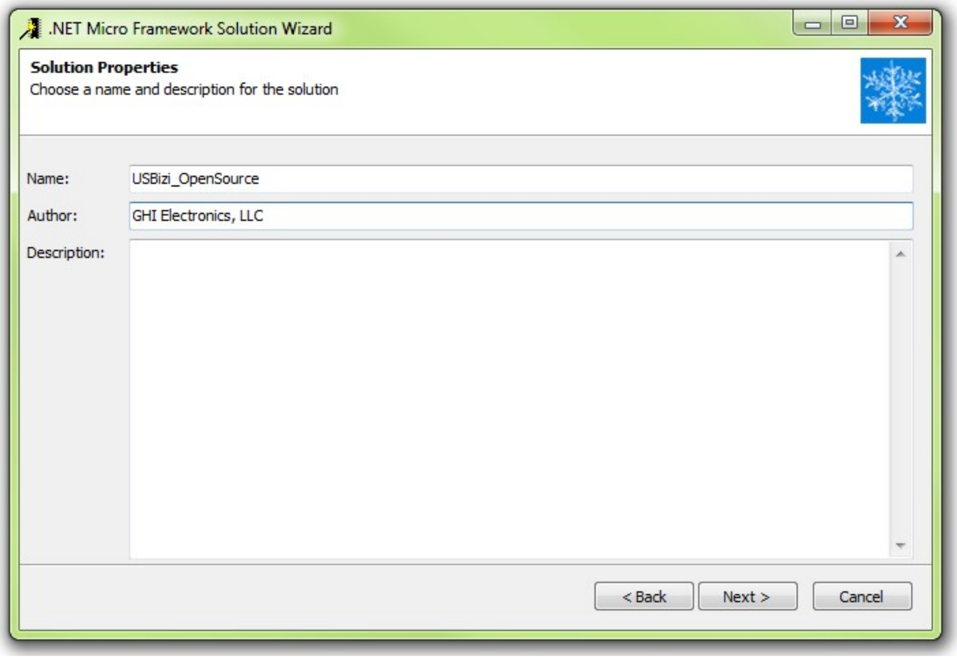
Project Path:
C:\MicroFrameworkPK_v4_1\Solutions\EA_LPC2478
\EA_LPC2478.settings

Processor Type: LPC24XX

○ Open Solution

Find a Solution Document...

Put USBizi_OpenSource for name and put your name for author.



.NET Micro Framework Solution Wizard

**Solution Properties**

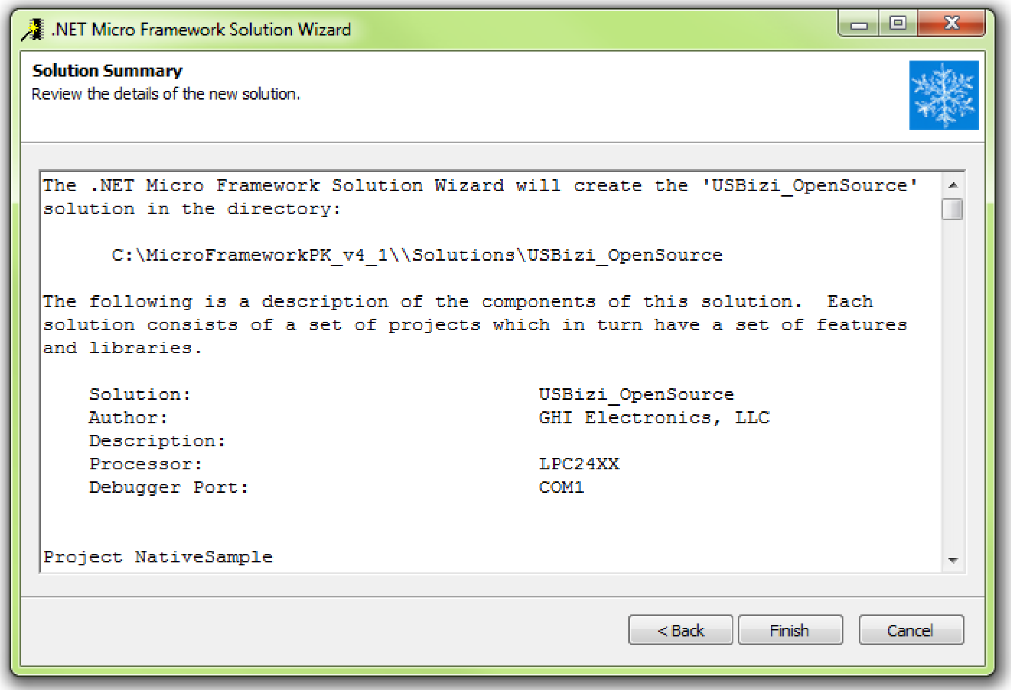
Choose a name and description for the solution

Name: USBizi_OpenSource

Author: GHI Electronics, LLC

Description:

Do not make any changes on the rest of the settings and keep clicking next till you are at the “Solution Summary”. Click Finish and now you have your new solution.

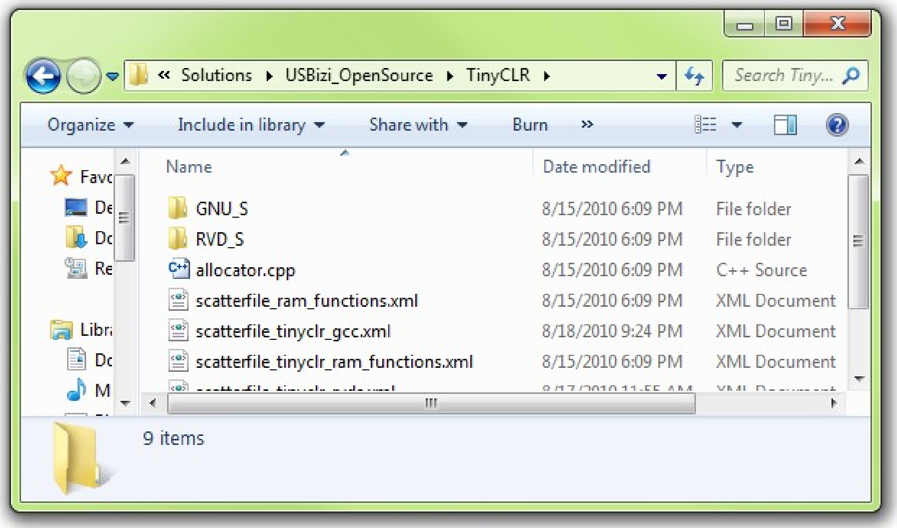


**Solution Summary**

Review the details of the new solution.

```
The .NET Micro Framework Solution Wizard will create the 'USBizi_OpenSource'
solution in the directory:

      C:\MicroFrameworkPK_v4_1\\Solutions\USBizi_OpenSource

The following is a description of the components of this solution.  Each
solution consists of a set of projects which in turn have a set of features
and libraries.

    Solution:                                     USBizi_OpenSource
    Author:                                       GHI Electronics, LLC
    Description:
    Processor:                                    LPC24XX
    Debugger Port:                                COM1


Project NativeSample
```

Navigate into the solution to make sure the new files are there



| Name | Date modified | Type |
|---|---|---|
| GNU_S | 8/15/2010 6:09 PM | File folder |
| RVD_S | 8/15/2010 6:09 PM | File folder |
| allocator.cpp | 8/15/2010 6:09 PM | C++ Source |
| scatterfile_ram_functions.xml | 8/15/2010 6:09 PM | XML Document |
| scatterfile_tinyclr_gcc.xml | 8/18/2010 9:24 PM | XML Document |
| scatterfile_tinyclr_ram_functions.xml | 8/15/2010 6:09 PM | XML Document |

9 items

The last thing we need to do is to make sure the new cloned solution we have will compile. So go ahead and compile the USBizi_OpenSource solution before we make any changes to it.

# 13. Memory Layout

Xml file...regions...output file verify

# 14. Bootstrap

## 14.1. Bootstrap Debugging

Use LED

# 15. NativeSample

## 15.1. Blink LED

## 15.2. Debug Messages

# 16. Booting Firmware

## 16.1. Bootup Messages

## 16.2. MFDeploy Ping

# 17. Managed Applications

## 17.1. Block Storage

# 18. Interops

GHI started with virtual COM port..

GHI exclusive features

RLP

## 18.1. PWM Interop

# 19. Final Words

If you found this book useful and it saved you few minutes of research then I have accomplished what I had in mind. I very much thank you for your downloading and reading this book.

## 19.1. Further Reading

This book only covers the basics of C# and .NET Micro Framework. This is a list of some resources to learn more:

- My blog is always a good place to visit
  http://tinyclr.blogspot.com/
- The Micro Framework Project website is an excellent resource
  http://www.microframeworkprojects.com/
- A good and free eBook to continue learning about C# is available at
  http://www.programmersheaven.com/2/CSharpBook
- Jens Kuhner excellent book on .NET Micro Framework
  http://www.apress.com/book/view/9781430223870
- USB complete is an excellent book on USB
  http://www.lvr.com/usbc.htm
- Wikipedia is my favorite place for information about everything!
  http://en.wikipedia.org/wiki/.NET_Micro_Framework
- .NET Micro Framework main page on Microsoft's website
  http://www.microsoft.com/netmf

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